Wetting-drying cycles effect on persistence of aggregates promoted by natural mucilage, PAM, iron chloride and alum

M. HENRÍQUEZ-RODRÍGUEZ[a],, J. PÉREZ-ARIAS[b], J. GASCÓ-MONTES[b] O. RODRIGUEZ-RODRIGUEZ[a]
[a]*Universidad Centroccidental Lisandro Alvarado (UCLA). Barquisimeto, Apartado 400. Venezuela.*
[b]*Universidad Politécnica de Madrid (UPM). Madrid, Spain.*

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INTRODUCTION

Organic matter as well as iron and aluminium are determinant on formation and stability of soils´ micro-aggregates and peds. The functional groups of synthetic flocculating conditioners materials like PAM, are similar to those of natural polymers found on soil organic matter which release H^+ and leave negative charges exposed (Bouranis *et al.*, 1995). Henríquez *et al.* (2000) studied the effect of the mucilage extracted from cactaceae plants on soils hydraulic conductivity (HC), depth of surface applied water penetration (WP) and concentration of suspended particles (CSP). All treatments increased HC and WP and reduced CSP.
Effects of organic and inorganic conditioners on aggregation of suspended particles and alternated wetting-drying cycles influence on persistence of aggregates formed by the conditioners: Cardon Dato mucilage (CD) (Stenocereus griseus (Haw) F. Buxb), iron chloride, aluminum chloride and a commercial poliacrylamide (PAM) were studied.

MATERIALS AND METHODS

Doses tested were: 50 mg L^{-1} CD; 3 cmol+ kg^{-1} Fe^{+3}; 3 cmol+ kg^{-1} Al^{+3}; 1.5 cmol+ kg^{-1} Fe^{+3} + 1.5 cmol+ kg^{-1} Al^{+3}; 50 mg L^{-1} CD + 1.5 cmol+ kg^{-1} Fe^{+3}; 50 mg L^{-1} CD + 1.5 cmol+ kg^{-1} Al^{+3}; 50 mg L^{-1} CD + 1.5 cmol+ kg^{-1} Fe^{+3} + 1.5 cmol+ kg^{-1} Al^{-3}; 10 mg L^{-1} of PAM; and distilled water as control. An oven dried (60-70°C) Spain kaolin powder was used as substrata. Equal amounts of kaolin powder were suspended in each conditioner and submitted to four cycles of drying and wetting. The comparative effect in the aggregation index (AgI) for three different sizes of aggregates (< 6 μm; 6-25 μm & >25 μm), among those 10 treatments was analyzed by a completely randomized model with four repetitions. The effect of each wetting-drying cycle for each treatment was also analyzed by a totally randomized model with four repetitions.

RESULTS AND DISCUSSION

The AgI of the 50 mg L^{-1} CD treatment was less persistent than the one of 10 mg L^{-1} of PAM, and the AgI of them both were less persistent than those of all treatments that included Fe and Al.
The smaller AgI persistence of these two organic conditioners could be related to their lower bonding strength among aggregated particles, which reduces their effectiveness in avoiding particles dispersion during wetting.
The structuring effects of Al and Fe were more long-lasting than the one induced by the organic conditioners.

CONCLUSIONS

1. The CD mucilage produced a micro-aggregation effect similar to the one of PAM, even though PAM10 was slightly more persistent than CD50.
2. Fe and Al produced more persistent effects on micro-aggregation than the CD and PAM treatments.
3. The Fe and Al conditioners used, either applied alone or combined with the CD treatment, increased the micro-aggregation in the following order: Fe > Al > FeAl > FeAlCD50 > FeCD50 > AlCD50.
4. Application of wetting-drying cycles produce dispersion on the kaolin substrata tested with DW, PAM10 and CD50 on aggregates > 25μm.
5. Fe and Al treatments reduced the ΣCEC of the kaolin.

Table 1. Cations, EC and pH in the C4 saturation extract

Treatment	Ca	Mg	K	Na	Σ Cations	EC	pH
	$mmol_c\ L^{-1}$	$mola\ L^{-1}$	$mmol_c\ L^{-1}$	$mmol_c\ L^{-1}$	$mmol_c\ L^{-1}$	$dS\ m^{-1}$	
DW	2.93	1.00	0.23	0.13	4.30	0.651	7.49
PAM10	3.29	1.09	0.20	0.13	4.72	0.701	7.43
Fe	31.85	11.85	0.71	0.16	44.56	4.988	3.41
Al	33.30	11.93	0.82	0.16	46.21	4.994	4.41
FeAl	25.85	9.05	0.71	0.15	35.76	4.413	4.57
CD50	4.26	1.39	0.26	0.14	6.04	0.895	7.14
FeCD50	12.70	4.77	0.48	0.13	18.08	2.107	6.62
AlCD50	14.75	5.43	0.52	0.14	20.85	2.641	6.53
FeAlCD50	21.23	7.61	0.56	0.15	29.54	4.155	4.46

Table 2. Aggregation indexes for particles < 6 μm

Wetting-drying cycle	Conditioners								
	DW	PAM10	Fe	Al	FeAl	CD50	FeCD50	AlCD50	FeAlCD50
	Aggregation Index								
C1	0.61a	0.48a	*	*	*	0.43b	*	*	*
C2	0.41b	0.33b	*	*	*	0.43b	*	*	*
C3	0.63a	0.55a	*	*	*	0.43b	*	*	*
C4	0.63a	0.56a	*	*	*	0.66a	*	*	*

Table 3. Aggregation indexes for particles 6-25 μm.

Wetting-drying cycle	Conditioners								
	DW	PAM10	Fe	Al	FeAl	CD50	FeCD50	AlCD50	FeAlCD50
	Aggregation Index								
C1	0.66b	0.59c	0.01b	0.01c	0.01b	0.65b	0.48c	0.55b	0.01c
C2	0.88a	0.90a	0.51a	0.67a	0.57a	0.63b	0.82a	0.79a	0.12b
C3	0.73b	0.73b	0.01b	0.30b	0.01b	0.81a	0.64b	0.53b	0.42a
C4	0.76b	0.70bc	0.01b	0.01c	0.01b	0.74a	0.55c	0.60b	0.01c

Table 4. Aggregation indexes for particles 6-25 μm.

Wetting-drying cycle	Conditioners								
	DW	PAM10	Fe	Al	FeAl	CD50	FeCD50	AlCD50	FeAlCD50
	Aggregation Index								
C1	0.38a	0.57a	1.64a	1.64a	1.64a	0.56a	1.16a	1.10a	1.64a
C2	0.37a	0.42b	1.15b	0.97c	1.08b	0.59a	0.83c	0.86b	1.53b
C3	0.30b	0.37c	1.64a	1.35b	1.64a	0.41b	1.01b	1.12a	1.24c
C4	0.27b	0.40bc	1.65a	1.64a	1.64a	0.25c	1.11a	1.10a	1.64a

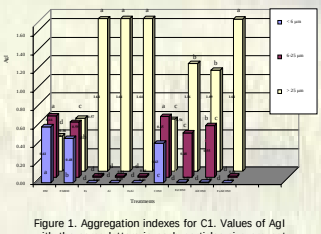

Figure 1. Aggregation indexes for C1. Values of AgI with the same letters in each particles size are not significantly different.

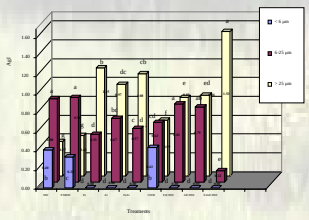

Figure 2. Aggregation indexes for C2. Values of AgI with the same letters in each particles size are not significantly different.

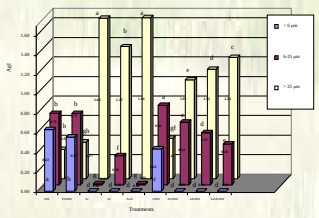

Figure 3. Aggregation indexes for C3. Values of AgI with the same letters in each particles size are not significantly different.

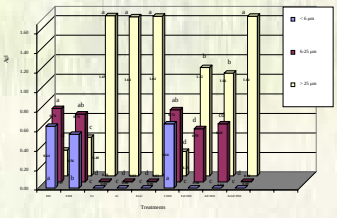

Figure 4. Aggregation indexes for C4. Values of AgI with the same letters in each particles size are not significantly different.

LITERATURE CITED

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